How credit ratings affect sovereign credit risk: cross-border evidence in Latin American emerging markets

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Abstract

This article builds upon previous literature by providing a better understanding of how contagion changes in bordering sovereign CDS emerging markets resulting from credit rating events. To that end, we follow the novel GVAR methodology using data from six Latin American emerging countries during an extensive sample period from 2004 to 2014. Our findings show evidence for the existence of significant and asymmetric cross-border effects. In particular, a competition effect is observed before the event occurs, indicating that non-event countries suffer (benefit) from upgrades (downgrades) in Brazil, Mexico and Chile (in Argentina and Brazil). In contrast, an imitation effect is observed after rating upgrades in Chile, to the benefit of bordering non-event countries.

Keywords: CDS spreads, credit ratings, emerging markets, spillover effects, GVAR

JEL classification: F30, G15, G24, C50

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1. Introduction

One of the most significant financial events of the past decade has been the rapid growth experienced by the OTC credit derivatives market. Since 2008, credit default swaps (hereafter, CDSs)[1] are the most widely traded credit derivative instrument used to efficiently transfer credit risk, offering opportunities for business diversification and the effective hedging of counterparty risk. According to the International Swaps and Derivatives Association (ISDA), the notional outstanding value of the CDS market increased from $8.4 trillion at the end of 2004 to $21 trillion at the end of 2013, marking a peak of $58 trillion at the end of 2007. Nowadays CDSs are considered a good proxy for credit risk, where the probability of default of the reference entity (and therefore the level of risk) is assumed by the counterparty.[2] Furthermore CDSs are the most liquid credit derivative product and account for about half the amount of credit derivatives traded on the derivatives market.

Due to its recognised hedging qualities, the expansion of emerging debt markets might have led to the recent increase of the fraction of the CDS contracts written on high-yield debt obligations. Emerging nations are amongst the largest high-yield borrowers in the world; however, when facing financial distress, countries generally do not enter traditional bankruptcy proceedings (hence don't liquidate their assets), so the nature of default risk is somewhat different to that of a traditional debtor. In practice, countries go through debt restructuring mechanisms in which defaulted bond are exchanged for new longer maturity and lower yield debt instruments.

Furthermore, recent literature has focused on the impact of sovereign credit ratings on sovereign debt, especially for emerging economies. Christopher *et al.* (2012) assert that sovereign ratings enhance the transparency of an emerging country's credit risk profile, whereas Kim and Wu (2008) argue that rating changes within emerging economies have determinant information about the governments' capacity to deal with both, their financial

[1] A CDS is essentially an insurance contract that provides protection against the risk of default by a specific reference entity. The CDS spread is the periodic rate that a protection buyer pays on the notional amount to the protection seller for transferring the risk of a credit event for some period.
[2] There are several advantages of using CDS spreads instead of bond spreads. See for instance, Blanco *et al.* (2005), Norden and Weber (2009) and Jorion and Zhang (2009), amongst others.

obligations as well as their refinancing conditions, as rating changes provide information about the institutional quality for financial and economic development.

Theoretically, both sovereign credit risk levels measured by CDS spreads and announcements of a credit rating changes should reflect the same information content, given that both are based on publicly available information.[3] If this were to be true, we would not expect CDS spreads to react to a rating announcement. However, several recent papers (Finnerty *et al.*, 2013, amongst others) find that the CDS market anticipates credit rating news. This literature has focused on analysing endogenic effects within a country or a firm, and hence little attention has been paid to cross-border effects. Following Wengner *et al.* (2015), we argue that the study of the response in the country that the rating event occurs is incomplete, because it does not reveal how much of the event's information is country-specific and how much is market-wide. In fact literature has demonstrated that a significant part of sovereign CDS spreads is explained by common factors such as investors' risk appetite and global economic fundamentals (Remolona *et al.*, 2008, Longstaff *et al.*, 2011, Eichengreen *et al.*, 2012), so any credit rating announcement containing new information should have spillover effects on the CDS spreads of other sovereigns. Cross-border analyses allow us to investigate if non-event countries (seen as competitors) benefit or not from the rating event in a given country. In this paper we shall address this issue.

We use the information contained in CDS contracts of Latin American emerging economies from 2004 to 2014 to investigate the cross-border spillover effects of the credit rating events. In particular, we test whether or not the contagion effect amongst sovereign CDSs has changed depending on rating announcements. The contagion is measured in terms of return spillovers following a Generalized VAR (GVAR) approach (Diebold and Yilmaz, 2012). More specifically, we calculate the change in the pairwise contagion before and after the credit rating event. Finally, we contrast whether they are statistically significant on average. We distinguish between positive and negative events, which enables us to analyse whether sovereign CDSs of non-event countries respond symmetrically to rating upgrades and downgrades in a given country.

[3] Intuitively, one should expect a negative relationship between them, since the higher the CDS spread, the lower the credit rating.

To sum up, we seek to address the following questions: Is there a significant change in the spillover effect on CDS spreads of non-event sovereign entities due to credit rating announcements of a given country? Is there a significant change in the contagion before or after these events? Are the reactions symmetric in response to credit rate upgrades and downgrades?

Our results are of economic relevance: portfolio managers and investors could estimate and evaluate the changes caused by the spillover effects of future credit rating announcements in one country on the non-event bordering economies. That way, they could use CDS market information in order to appropriately construct and hedge portfolios that are sensitive to sovereign credit risk contagion. Moreover, it allows us to identify the competitive effect produced by credit rating events in emerging cross-border non-event economies, which plays a pivotal role for discussions of future regulations. These findings have implications for international diversification and for a better understanding of the global/regional capital market structure.

The remaining part of this paper is organised as follows: section 2 reviews the related literature, section 3 describes the data, section 4 discusses the methodological approach while section 5 presents the results and section 6 concludes.

2. Literature review

Previous research on the impact of rating changes has focused uniquely on the direct effect, that is, the impact on CDS markets within the same firm or country where the event occurs. Hull *et al.* (2004), Norden and Weber (2004), Galil and Soffer (2011) and Finnerty *et al.* (2013) amongst others, conclude that international sovereign and/or corporate CDS markets anticipate credit rating events, particularly for downgrades.[4]

[4] Additionally, the literature has analyzed the effect of rating announcements on distinct markets: on bond markets (Hite and Warga, 1997, Steiner and Heinke, 2001), stock markets (Dichev and Pietroski, 2001, Behr and Güttler, 2008) or both (Hand *et al.*, 1992). They all find evidence for analogous results: there is a market response to negative credit rating events, but no (or weak) significant reaction to positive ones. Hence, downgrades seems to be better anticipated than upgrades.

A growing strand of the literature looks at the cross-border spillover effect, measuring whether the effect of rating announcements also extends to bordering economies. Gande and Parsley (2005), Böninghausen and Zabel (2015), Ferreira and Gama (2007) and Baum *et al*. (2016) analyse the effect on international developed and emerging sovereign bond spreads (the first three papers) and stocks (latter one). They all find evidence for the existence of asymmetric spillovers, with a bigger impact of downgrades, concluding that geographic proximity and emerging market status amplify this effect. In the same line, Christopher *et al.* (2012) use data from stock and bond markets of nineteen emerging economies and conclude that co-movements within a region respond heterogeneously to sovereign ratings information. For the case of bonds in particular, they find a competitive effect for downgrades, since they lead to investors shifting funds from the downgraded market to the surrounding region and to a greater extent to countries with higher credit ratings.

Finally, a few studies have included the CDS market in the analysis of the cross-border effect of credit rating events. Afonso *et al.* (2012) investigate the impact of sovereign credit ratings on European Union sovereign bond and CDS spreads, concluding that spillover effects are mostly unsignificant for sovereign CDSs, while they are quite significant for sovereign bonds. In this latter case, they find that the effect exists especially for Eurozone countries and from lower rated countries to higher rated countries. In contrast, Drago and Gallo (2016) find evidence of significant spillovers of downgrades on the Eurozone CDS market and they conclude that the spillovers' size is due to economic and financial conditions of analysed countries. At the international corporate level, Wengner *et al.* (2015)'s findings indicate significant spillovers on non-event firms. Concretely, downgrades (upgrades) display a competitive (imitation) effect around the event, with negative ones having a greater impact. Finally, using sovereign CDS data for twenty-two international emerging countries, Ismailescu and Kazemi (2010)'s results suggest that positive events are more likely to spill over to other emerging countries. This finding differs from the existing and previously mentioned literature related to sovereign debt markets.

In this paper, we focus our attention on the analysis of spillover effects that a credit rating event occurring in one emerging country has on the CDS spreads of other bordering economies. The relationship between sovereign debt and credit ratings plays a pivotal

role, especially for emerging market investments, given the great expansion of these economies over recent years. We differ from the related papers in different ways. First, we do not only study the effect surrounding the event, but we also analyse the impact before and after the event occurs. Second, our paper also contributes to the related literature in that we focus exclusively on neighbour emerging countries within a particular area, since we argue that the cross-border spillover effect might be more pronounced amongst bordering countries than amongst countries belonging to distinct emerging areas. In particular, we focus on Latin American emerging markets and on an extensive sample period from 2004 to 2014. In addition, we provide not only a cross-sectional study for all available countries in Latin America, but we also look at the individual national level. The former will inform us as to whether or not an average spillover effect exists amongst all the countries, and the latter will allow us to identify which countries are the transmitters of the spillover effects on the non-event countries within the area. We argue that it seems more likely to find significant cross-border effects amongst countries within the same area, since they are more likely to be seen as competitors. Finally, we follow a distinct methodology since we test whether or not significant spillover effects exist in terms of changes in financial contagion amongst the six emerging economies. The idea is to see if the existing contagion between CDSs is significantly affected by credit rating announcements in a given country. The issue of contagion in financial markets is of fundamental importance (see Celik, 2012, amongst others) as it has serious consequences for the global economy in relation to monetary policy, optimal asset allocation, risk measurement, capital adequacy and asset pricing. To the best of our knowledge this has not been investigated up to now.

Therefore, we contribute to the literature in that we bring together the literature on the impact of credit rating events on distinct financial markets and the literature on financial contagion in order to provide a better understanding of how contagion changes in bordering sovereign CDS markets resulting from credit rating announcements.

Although it is quite an intuitive concept, contagion is difficult to define and measure empirically. Kaminsky *et al.* (2003), Bae *et al.* (2003) and Longstaff (2010), amongst others, define contagion as an episode in which there is a significant increase in cross-market linkages when a shock occurs. According to Forbes and Rigobon (2002), contagion exists if there is a significant increase in cross-market linkages after a shock in

one country, whereas Bekaert *et al.* (2014) define contagion as the co-movement in excess of what can be explained by fundamentals taking into account their evolution over time. Pericoli and Sbracia (2003) review different definitions and related measures of contagion that are frequently used in the literature,[5] concluding that all methodologies are drawn by limitations and caveats. In this study, we define contagion as the change in the propagation mechanism when a shock occurs and we measure it in terms of return spillovers using the GVAR methodology of Diebold and Yilmaz (2012). This approach is particularly suited to our purposes, as it enables us to compute pairwise contagion change in a non-event bordering country resulting from a credit rating announcement. To our knowledge, this paper is the first to work with the novel GVAR method in order to document spillover effects in Latin American sovereign CDS markets caused by credit rating announcements.

3. Data

Our daily dataset consists of sovereign CDS spreads for Latin American emerging countries and was obtained from Datastream. We selected US dollar denominated, senior tier, 5-year CDS quotes, since these contracts are generally considered to be the most liquid ones and constitute the majority of the entire CDS market (Jorion and Zhang, 2007 and Eichengreen *et al.*, 2012). Covering almost a decade, we work with data from April 22, 2004 to January 27, 2014 and look at six Latin American emerging markets; namely: Argentina, Brazil, Chile, Colombia, Mexico and Peru.[6] Hence, our dataset results in 15,288 daily panel observations for a time period of 2,548 days.

Descriptive statistics of the CDS data for each country are reported in Table 1, while Figure 1 illustrates the daily time evolution of all the countries in our sample (Panel A) and the average CDS spreads through all of them (Panel B). The mean CDS spreads varied significantly by country ranging from 69.17 bps for Chile to 1,016.35 bps for Argentina. Two sharp increases in CDS premiums are observed during the sample period; the first corresponds to the 2008 global credit crisis, affecting all countries and Argentina

[5] They include changes in the probability of currency crises, volatility spillovers, Markov-switching models, correlation or co-movements, and changes in the transmission mechanism.
[6] Following FTSE country classification as of September 2014, we cover all the types of emerging countries: advanced emerging (Brazil and Mexico), secondary emerging (Chile, Colombia and Peru) and frontier emerging (Argentina).

in particular, and the second sharp increase occurs at the end of the sample period and reflects the Argentinian credit risk troubles.

Finally, we collect rating announcement events from S&P's Sovereign Rating and Country Transfer and Convertibility Assessment Histories. Table 2 shows S&P's rating categories, where we transform them into a discrete variable from 1 to 22. Literature has shown that S&P rating changes occur more frequently; hence, S&P provides us with a larger data set, which is less anticipated by market participants and precedes announcements of other rating agencies (Gande and Parsley, 2005, Reisen and Von Maltzan, 1999). In this study, rating events consist of changes in ratings and/or outlooks. Positive (negative) events are upgrades (downgrades) of S&P's letter credit ratings or revisions in the sovereign country's credit outlook.[7]

Table 3 displays the distribution of credit rating events per country and per year. We observe 49 credit rating events for the six emerging markets in our sample, where rating upgrades clearly dominate with 40 observations in contrast to 9 downward observations. Chile, Colombia and Peru do not show negative events, while for Argentina, rating downgrades seem to be predominant. Twenty-one of the 40 positive events were reported in the first four years only, specifically until 2008. The global financial crisis of 2008 is accompanied by four downgrades reported in 2008 and 2009, affecting Argentina and Mexico. After the climax of the crisis, positive events dominate again with 16 credit rate upgrades against 4 downgrades, 3 of them affecting Argentina during 2012 and 2013, a period characterised by the decline of Argentinian credit quality.

Figure 2 shows the credit rating evolution over time for each country. Overall, three main groups are observed. First, Chile stands out as the Latin American country with the highest quality credit (investment grade). Its S&P rating is around A on average over time, which means a strong payment capacity according to S&P. Next, Brazil, Colombia, Mexico and Peru are countries placed at the limit between investment grade and non-investment grade categories, which means that overall these countries are likely to fulfil their obligations, but there is ongoing uncertainty. Finally, Argentina is the Latin

[7] Credit Watches are not included because none of them occur during our sample period.

American country with the worst rating category over time. In fact, its S&P rating is around CCC, standing for a very high credit risk.

4. Methodology

The methodology follows a two-stage empirical procedure. In the first stage, we use sovereign CDS spreads, more precisely CDS log-returns, as an indicator of sovereign credit risk and measure the contagion effect amongst each pair of countries over time in a rolling framework. To do that we follow the GVAR methodology developed by Diebold and Yilmaz (2009, 2012) and consider the *net pairwise return spillover* indices,[8] which measure the actual contagion between each pair of sovereign CDS return series and is given by equation (A.4). In particular, this index $NPS^{G}_{i\rightarrow j}$ indicates that country *i* is a net transmitter (receiver) of sovereign CDS return spillovers to (from) country *j*.

The second stage of the empirical procedure consists of measuring the impact of credit rate announcements for a given country on the cross-border contagion between sovereign CDSs. In particular, we calculate the change in the pairwise contagion before and after each credit rating event,[9] known as the prior and post effect:

$$Prior\text{-}effect = NPS^{G}_{i\rightarrow j_t} - NPS^{G}_{i\rightarrow j_{t-s}}, \quad \text{for } s = 1,2,\dots,25 \tag{1}$$

$$Post\text{-}effect = NPS^{G}_{i\rightarrow j_{t+s}} - NPS^{G}_{i\rightarrow j_t}, \quad \text{for } s = 1,2,\dots,25 \tag{2}$$

where t is the day of the credit rating event, and s denotes the number of days in the window before and after the event, where we test whether cross-border contagion amongst sovereign CDSs has significantly changed before and/or after a sovereign credit rating announcement in a given country.[10] More concretely, we test if prior and post effects are significantly different from zero on average using a standard *t*-test. First, we take into account all the available countries and events in the sample, to see if cross-

[8] For a more in-depth explanation of the GVAR methodology and construction of contagion measures, see Appendix A.

[9] The rolling GVAR analysis leads to the loss of the first three credit rating events (all positive): the two reported in 2004 for Brazil and Peru, and the first one reported in 2005 for Mexico. Hence, we finally work with 46 credit rating announcements in total: 37 upwards and 9 downwards.

[10] The maximum value of 25 days is selected to avoid losing those events that are close to the beginning and the end of the sample period.

border contagion changes amongst CDSs due to sovereign credit rating events do exist when considering the six emerging markets all together. Second, we test the significance of prior and post effects of sovereign rating news for each country within the Latin American area. We argue that it seems more likely to find significant effects amongst the countries belonging to the same region, since they are more likely to be seen as competitors. Moreover, we distinguish between positive and negative events, which enables us to analyse whether sovereign CDSs of non-event countries respond symmetrically to rating upgrades and downgrades in a given country.

If the prior (post) effect is revealed to be statistically significant for the window [t–s, t] ([t, t+s]), we would find evidence for the existence of a significant change in the cross-border contagion of sovereign credit risk s days before (after) the rating event. A significant and positive (negative) effect means an increase (decrease) of cross-border contagion of sovereign credit risk due to a rating event.

The use of rating upgrades and downgrades separately allows us to identify whether countries within the same area are seen as direct competitors. If upgrades in a given country lead to a significant and positive (negative) change in cross-border contagion, it indicates that non-event countries benefit (suffer) from the rating event. The opposite is given for downgrades. If downgrades in a given country lead to a significant and positive (negative) change in cross-border contagion, it indicates that non-event countries suffer (benefit) from the rating event.

5. Empirical results

Table 4 displays the credit rating events' prior and post significant effect on average through all the countries and all the events, while distinguishing between positive and negative events. We observe that the sovereign CDSs of the six Latin American countries under study experience a significant change in the cross-border contagion of sovereign credit risk due to a rating event.

Regarding the prior-effect, we notice that they are always negative, indicating that cross-border contagion decreases prior to the event. With regard to downgrades, the prior-effect is significant for all periods analysed, while the upgrades have a significant effect only in

the short-term (from 1 to 8 days prior to the event) and with a smaller impact in absolute value. These findings indicate that bordering non-event countries suffer (benefit) from upgrades (downgrades), which reflect a competition effect before the event occurs.

The sign of significant post-effects is always positive, indicating that after the event cross-border contagion increases significantly, and is basically due to positive credit rating announcements. This post-effect emerges three days after the event and it is more pronounced (in terms of magnitude) 20 days after the event. Finally, it is notable that upgrades benefit bordering non-event countries, indicating an imitation effect after the positive event occurs.

In a next step, we study whether there is any particular country that leads the cross-border spillover effect to all others, with the purpose of isolating each transmitting countries. Table 5 displays the results. When the effects are significant, one observes that their estimated sign is consistent with the sign previously obtained on average across all countries. The significant prior (post) effects are always negative (positive) indicating a decrease (rise) in contagion, before (after) the event occurs.

If we take a deeper look, the competition effect previously observed prior to the event for downgrades is transmitted by Argentina and Brazil. Both countries display significant values for all periods analysed, however, the impact is greater in the short term (from 3 to 5 days) in the Argentinian case and in the long term (from 15 to 25 days) in the Brazilian case. On the other hand, the competition effect previously observed prior to the event for upgrades is due to Brazil and Mexico and to a greater extent to Chile, all of them in the short term. In addition to that, it is noticeable that Chile is the only transmitter (in the short term) of upgrades after the event occurs, with an imitation effect, meaning that after the rating events, only positive news in Chile have a significant impact on bordering countries in terms of an increase in contagion.

To sum up, we find evidence that sovereign CDSs react to rating announcements concerning other sovereigns. The effect is asymmetric, with negative news having a quantitatively different impact than positive announcements; a finding in line with previous related literature on sovereign debt markets (Gande and Parsley, 2005,

Böninghausen and Zabel, 2015, Christopher *et al.*, 2012, amongst others[11]). This result, although expected, is notable because only nine downgrades are observed in the sample. The Argentinian case is worthy of consideration, it has the worst credit qualification, linked to a very high credit risk according to S&P. In fact, the last new rating for Argentina was a rating change to CCC+ in September 2013, which finished with a CCC- rating level in August 2014. The case of Brazil is particularly remarkable. Its only outlook downgrade in June 2013 had a considerably significant impact in all periods and magnitudes. This rating event occurred in the last part of the sample. It was a negative revision of its credit quality BBB, leading to a BBB- in June 2014, being quite near the limit of the speculative grade status. Finally, these downgrade transmissions are just observed in the days before the rating announcement and the effect is one of competition. These findings indicate that non-event rival countries benefit from reduced refinancing capacity of the event country (due to its negative rating event) and they may be able to capture new borrowers from the displaced country within the area. In addition to that, the event countries correspond with the lower credit quality rating, indicating that the spillover goes from lower rated countries to higher rated ones, as pointed out by Christopher *et al.* (2012) and Afonso *et al.* (2012). In contrast, regarding upgrades, it stands out that amongst the high number of positive rating news observed in the sample, practically only the four occurring in Chile display a significant effect, both prior and post the event. Chile is the country with the greatest credit quality, having a strong payment capacity according to S&P (around A on average). The impact is one of competition before the positive event occurs in Chile, and of imitation after it. It indicates that positive rating news in Chile negatively affects bordering non-event countries before the event, but positively after it.

Figure 3 shows the evolution over time of the *net directional contagion* from a given country to all other countries. It indicates if the isolated country is a transmitter or receiver of contagion when the measure is positive or negative, respectively.[12] Overall, previous results are confirmed. Rating downgrades in Argentina go with a decrease in contagion before the event occurs. What are remarkable are the negative events of 2012. Although Argentina is shown to be a receiver of contagion from bordering countries over time,

[11] Wengner *et al.* (2015) find the same result using corporate CDSs. Ismailescu and Kazemi (2010) find the opposite result using sovereign CDSs of emerging countries. However, they use a distinct methodology and a very heterogeneous sample of international emerging economies.

[12] The particular expression for the *net directional measure* is given by equation (A.5) in Appendix A.

before 2012 the contagion decreases a lot and it starts to increase after 2012, before the rating downgrades occur. By contrast, two upgrades in Argentina stand out from the rest: March 2006 and April 2008. Their impact seems to be evident, since Argentina becomes to be a transmitter between these two dates.[13] In the case of Brazil, we observe how both rating upgrades and downgrades go with a decrease in contagion before the event occurs. In particular, three upgrades stand out: February 2006, May 2007 and November 2011. On the other hand, the only downgrade (and outlook) in Brazil, in June 2013, has a significant impact. During June 2013 Brazil becomes a receiver of contagion, whereas its role is that of a transmitter during the rest of the sample period. In the case of Mexico, it is worth mentioning how contagion increases considerably prior to the upgrade of October 2007. In fact, the impact is so remarkable that Mexico goes from being a receiver to a transmitter of contagion during that period. Finally, Chile displays a decrease in contagion before the upgrades and a decrease after them. The most notable event is the credit rating change of December 2007.

6. Conclusions

This paper focuses on sovereign CDS markets, and investigates cross-border spillover effects, in terms of changes in contagion, due to credit rating announcements in six Latin American emerging economies during the wide sample period from 2004 to 2014. More specifically, we focus on measuring the effect in terms of impact on contagion that rating announcements in a particular country have on sovereign CDS spreads of other countries located in the same region. The contagion is measured using the novel GVAR approach of Diebold and Yilmaz (2012). In particular, we first calculate the change in the pairwise contagion before and after each credit rating event using different windows of days. Next, we test whether or not they are significant on average, that is, whether or not contagion from the event country to bordering non-event countries has changed due to rating events. Additionally, we distinguish between positive and negative events in order to determine whether the reactions are symmetric in response to rating upgrades and downgrades.

[13] This result seems to conflict with previous analysis, where upgrades in Argentina have not revealed to be statistically significant (Table 5). However, it should take into account that the test identifies significant effects on average through all the upgrades together, which does not mean that any of them could be individually significant.

Our results generally show evidence for the existence of a significant change in the cross-border contagion of sovereign credit risk due to rating events in a given country. More specifically, the reactions are not symmetric in response to positive and negative announcements. Prior-effect results indicate that bordering non-event countries suffer (benefit) from upgrades (downgrades). It reflects a competition effect before the event occurs. Argentina and Brazil are the transmitters in the case of downgrades, indicating that the spillover goes from lower rated countries to higher rated ones. On the other hand, Brazil, Mexico and to a greater extent Chile, are the countries transmitting the competition effect observed before upgrades occur. Finally, regarding post-effects it is notable that upgrades benefit bordering non-event countries, indicating an imitation effect after positive events occur. As the only transmitter of this effect, Chile has a significant impact on the bordering countries in terms of an increase in contagion.

This study might have quite useful applications: after the recent global financial crisis, regulatory authorities were focused on measuring and controlling credit risk contagion given its significant impact on financial stability. In this sense, the quantification of the impact in terms of contagion produced by credit rating events on bordering non-event emerging economies is crucial. It permits the identification of the competition effect produced by negative and positive rating events in cross-border emerging economies. This information is also useful for investors and portfolio managers in order to appropriately construct and hedge investment portfolios of emerging countries sensitive to sovereign credit risk. Additionally, given the importance and the increase of the CDS market, which is considered a reasonable proxy of credit risk, these results may also be helpful for future regulators when implementing new capital adequacy frameworks for individual countries and portfolios in the sovereign credit risk market.

As an interesting further research, we propose to extend our paper in order to analyse the impact of sovereign credit rating events on bordering economies in terms of contagion, while distinguishing between systematic and idiosyncratic contagion. To do this, the idea is to follow the recent paper of Ballester *et al.* (2016) in order to see not only whether rating news imply a change in contagion in non-event countries, but also if the effect is linked to global emerging factors (systematic contagion) or linked to emerging specific factors (idiosyncratic contagion).

Appendix A

The GVAR methodology developed by Diebold and Yilmaz (2009, 2012) consists of a VAR-based spillover index particularly suited for the investigation of systems of highly interdependent variables. Spillovers are measured from a particular variance decomposition associated with an *N*-variable vector autoregression framework, which allows us to parse the forecast error variances of each variable into parts that are attributable to the various system shocks. The major advantage of this approach is that it eliminates the possible dependence of the results on ordering, in contrast to the traditional Cholesky factorisation.[14] In addition to that, it includes directional contagion indicators from/to a particular series, focusing not only on total spillovers.

First, a covariance stationary *N*-variable VAR(p) is estimated

$$x_t = \sum_{i=1}^{p} \phi_i \, x_{t-i} + \varepsilon_t \tag{A.1}$$

where $\varepsilon \sim (0, \Sigma)$ is a vector of independently and identically distributed disturbances and x_t denotes a *N*-variable vector of CDS log-returns. To ease the analysis, the model is written as the moving average representation $x_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i}$, where the $N \times N$ coefficient matrices are estimated by $A_i = \phi_1 A_{i-1} + \phi_2 A_{i-2} + \cdots + \phi_p A_{i-p}$, with A_0 being the identity matrix and $A_i = 0$ for $i < 0$.

Next, the variance decompositions are computed. The variance shares defined as the fractions of the *H*-step-ahead error variances in forecasting x_i that are due to shocks to x_j, for $H = 1,2, \ldots$, are given by

$$\theta_{j \to i}^{G}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \Sigma A_h' e_i\right)}, \text{ for } i, j = 1,2, \ldots, N \tag{A.2}$$

where σ_{jj} is the standard deviation of the error term for the j^{th} equation, i.e. the squared root of the diagonal elements of the variance-covariance matrix Σ and e_i is the vector with

[14] This problem is circumvented by exploiting the generalized VAR framework of Koop *et al.* (1996) and Pesaran and Shin (1998), amongst others.

1 as the i^{th} element and 0 otherwise. As the shocks of each variable are not orthogonalised, the row sum of the variance decomposition is not equal to 1. Thus, each entry of the variance decomposition matrix can be normalised by the row sum as

$$\tilde{\theta}^{G}_{j\to i}(H) = \frac{\theta^{G}_{j\to i}(H)}{\sum_{j=1}^{N}\theta^{G}_{j\to i}(H)} \times 100, \text{ for } i,j = 1,2,\dots,N \quad \text{(A.3)}$$

where the multiplication by 100 is expressing the result in percentage terms. Note that, by construction $\sum_{j=1}^{N}\tilde{\theta}^{G}_{j\to i}(H) = 100$ and $\sum_{i,j=1}^{N}\tilde{\theta}^{G}_{j\to i}(H) = N \times 100$.

Note also that return spillovers show the degree of variation in CDS log-returns of *i*, which is not due to the historical information of the CDS log-returns of *i* and *j* but to shocks (innovations) in CDS log-returns of *j*. This indicator takes higher values as the intensity of the contagion effect, caused by the specific shocks of *j*'s CDS log-returns, increases. In the extreme case in which there are no spillovers from one series to the other, the indicator is equal to zero.

Using the above normalised variance contributions, we can then construct *net pairwise return spillover* indices using a 200-day rolling windows,[15] which measure the actual contagion between each pair of return series, and are defined by

$$NPS^{G}_{i\to j} = \tilde{\theta}^{G}_{i\to j}(H) - \tilde{\theta}^{G}_{j\to i}(H), \text{ for } i,j = 1,2,\dots,N \quad \text{(A.4)}$$

It is simply the difference between the gross return shocks transmitted from *i* to *j* and those transmitted from *j* to *i*. Hence, it is positive (negative) when the impact of *i*'s shocks is higher (lower) than vice versa, indicating that *i* is a net transmitter (receiver) of return spillovers to (from) *j*.

Finally, the *net directional return spillover* indices measure the spillover transmitted by country *i* to all others.

[15] At each rolling window, the lag *p* of the GVAR model is determined using the likelihood ratio test and the Akaike information criterion, which confirms that *p* varies over time. The forecast horizon *H*=10 is selected using the *total return spillover* index of the GVAR, which measures the contribution of spillovers of return shocks across all the series to the total forecast error variance (Diebold and Yilmaz, 2012). This forecasting horizon is commonly used in similar studies (see for example Ballester *et al.*, 2016).

$$NDS_{i\to all}^{G}(H) = \sum_{\substack{j=1 \\ i\neq j}}^{N} \tilde{\theta}_{i\to j}^{G}(H) - \sum_{\substack{j=1 \\ j\neq i}}^{N} \tilde{\theta}_{j\to i}^{G}(H), \text{ for } i = 1,2,\dots,N \qquad \text{(A.5)}$$

Is the difference between the gross return shocks transmitted by i to all other countries and those received by i from all other countries. Positive (negative) values of the NDS index indicate that country i is, in net terms, a transmitter (receiver) of return spillover effects.

References

Afonso, A., Furceri, D., & Gomes, P. (2012). Sovereign credit ratings and financial markets linkages: application to European data. *Journal of International Money and Finance*, *31*(3), 606-638.

Bae, K. H., Karolyi, G. A., & Stulz, R. M. (2003). A new approach to measuring financial contagion. *Review of Financial studies*, 16(3), 717-763.

Ballester, L., Casu, B., & González-Urteaga, A. (2016). Bank fragility and contagion: Evidence from the CDS market. *Journal of Empirical Finance,* 38, 394-416.

Baum, C. F., Schäfer, D., & Stephan, A. (2016). Credit rating agency downgrades and the Eurozone sovereign debt crises. *Journal of Financial Stability*, *24*, 117-131.

Behr, P., & Güttler, A. (2008). The informational content of unsolicited ratings. *Journal of Banking & Finance*, 32(4), 587-599.

Bekaert, G., Ehrmann, M., Fratzscher, M., & Mehl, A. (2014). The Global Crisis and Equity Market Contagion. *The Journal of Finance,* 69, 2597-2649.

Blanco, R., Brennan, S., & Marsh, I. (2005). An empirical analysis of the dynamic relation between investment-grade bonds and credit default swaps? *The Journal of Finance*, *60*(5), 2255–2281.

Böninghausen, B., & Zabel, M. (2015). Credit ratings and cross-border bond market spillovers. *Journal of International Money and Finance*, *53*, 115-136.

Celik, S. (2012). The more contagion effect on emerging markets: The evidence of DCC-GARCH model. *Economic Modelling,* 29, 1946-1959.

Christopher, R., Kim, S. J., & Wu, E. (2012). Do sovereign credit ratings influence regional stock and bond market interdependencies in emerging countries? *Journal of International Financial Markets, Institutions and Money*, *22*(4), 1070-1089.

Drago, D., & Gallo, R. (2016). The impact and the spillover effect of a sovereign rating announcement on the euro area CDS market. *Journal of International Money and Finance*, *67*, 264-286.

Dichev, I.D., & Piotroski, J.D. (2001). The long–run stock returns following bond ratings changes, *The Journal of Finance,* 56(1), 173–203.

Diebold, F. X., & Yilmaz, K. (2009). Measuring Financial Asset Return and Volatility Spillovers, with Application to Global Equity Markets. *The Economic Journal*, 119(534), 158-171.

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, 28(1), 57-66.

Eichengreen, B., Mody, A., Nedeljkovic, M., & Sarno, L. (2012). How the subprime crisis went global: Evidence from bank credit default swap spreads. *Journal of International Money and Finance*, 31(5), 1299-1318.

Ferreira, M. A., & Gama, P. M. (2007). Does sovereign debt ratings news spill over to international stock markets? *Journal of Banking & Finance*, *31*(10), 3162-3182.

Finnerty, J.D., Miller, C.D., & Chen, R.R. (2013). The impact of credit rating announcements on credit default swap spreads. *Journal of Banking & Finance,* 37, 2011-2030.

Forbes, R., & Rigobon, R. (2002). No Contagion, Only Interdependence: Measuring Stock Market Co-movements. *Journal of Finance,* 57, 2223-2261.

Galil, K., & Soffer, G. (2011). Good news, bad news and rating announcements: An empirical investigation. *Journal of Banking & Finance*, 35(11), 3101-3119.

Gande, A., & Parsley, D.C. (2005). News spillovers in the sovereign debt market. *Journal of Financial Economics*, 75(3), 691-734.

Hand, J.R., Holthausen, R.W., & Leftwich, R.W. (1992). The effect of bond rating agency announcements on bond and stock prices. *The Journal of Finance*, 47(2), 733-752.

Hite, G., & Warga, A. (1997). The effect of bond-rating changes on bond price performance. *Financial Analysts Journal*, 35-51.

Hull, J., Predescu, M., & White, A. (2004). The relationship between credit default swap spreads, bond yields, and credit rating announcements. *Journal of Banking & Finance*, *28*(11), 2789-2811.

Ismailescu, I., & Kazemi, H. (2010). The reaction of emerging market credit default swap spreads to sovereign credit rating changes. *Journal of Banking & Finance*, 34(12), 2861-2873.

Jorion, P., & Zhang, G. (2007). Good and bad credit contagion: Evidence from credit default swaps. *Journal of Financial Economics*, 84(3), 860-883.

Jorion, P., & Zhang, G. (2009). Credit contagion from counterparty risk. *Journal of Finance,* 64(5)*,* 2053-2087.

Kaminsky, G. L., Reinhart, C. M., & Vegh, C. A. (2003). The unholy trinity of financial contagion. *The Journal of Economic Perspectives,* 17, 51-74.

Kim, S. J., & Wu, E. (2008). Sovereign credit ratings, capital flows and financial sector development in emerging markets. *Emerging markets review*, *9*(1), 17-39.

Koop, G., Pesaran, M.H., & Potter, S.M. (1996). Impulse response analysis in nonlinear multivariate models. *Journal of Econometrics*, 74(1), 119-147.

Longstaff, F. A., Pan, J., Pedersen, L. H., & Singleton, K. J. (2011). How sovereign is sovereign credit risk?. *American Economic Journal: Macroeconomics*, *3*(2), 75-103.

Longstaff, F.A. (2010). The subprime credit crisis and contagion in financial markets. *Journal of Financial Economics*, 97(3), 436-450.

Norden, L., & Weber, M. (2004). Informational efficiency of credit default swap and stock markets: The impact of credit rating announcements. *Journal of Banking & Finance*, 28(11), 2813-2843.

Norden, L., & Weber, M. (2009). The co-movement of credit default swap, bond and stock markets: An empirical analysis. *European financial management*, *15*(3), 529-562.

Pericoli, M., & Sbracia, M. (2003). A primer on financial contagion. *Journal of Economic Surveys*, 17(4), 571-608.

Pesaran, M.H., & Shin, Y. (1998). An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs*, 31, 371-413.

Reisen, H., & Von Maltzan, J. (1999). Boom and bust and sovereign ratings. *International Finance*, 2(2), 273-293.

Remolona, E.M., Scatigna, M., & Wu, E. (2008). A ratings-based approach to measuring sovereign risk. *International Journal of Finance & Economics*, 13(1), 26-39.

Steiner, M., & Heinke, V.G. (2001). Event study concerning international bond price effects of credit rating actions. *International Journal of Finance & Economics*, 6(2), 139-157.

Wengner, A., Burghof, H. P., & Schneider, J. (2015). The impact of credit rating announcements on corporate CDS markets–Are intra-industry effects observable? *Journal of Economics and Business*, *78*, 79-91.

Table 1: Descriptive statistics of the daily CDS spreads

This table presents the descriptive statistics for the daily 5-year sovereign CDS spreads expressed in basis points from April 22, 2004 to January 27, 2014 for six Latin American emerging markets: Argentina, Brazil, Chile, Colombia, Mexico and Peru.

	Mean	Std.Dev.	Min.	Max.
Argentina	1,016.35	1,024.02	1.50	4,961.65
Brazil	193.83	136.58	61.10	900.20
Chile	69.17	51.87	7.10	315.00
Colombia	184.49	105.86	64.70	613.30
Mexico	119.17	72.59	28.70	606.70
Peru	167.00	91.60	59.90	611.20
Average	291.67	197.15	70.63	1,116.82

Table 2: S&P's rating categories

This table presents Standard & Poor's rating categories and the transformation of them into a discrete variable from 1 to 22.

Characterisation of debt and issuer		S&P's rating	Numerical transformation
Investment grade	Highest quality	AAA	22
	High quality	AA+	21
		AA	20
		AA-	19
	Strong payment capacity	A+	18
		A	17
		A-	16
	Adequate payment capacity	BBB+	15
		BBB	14
		BBB-	13
Non-Investment grade	Likely to fulfil obligations, ongoing uncertainty	BB+	12
		BB	11
		BB-	10
	High credit risk	B+	9
		B	8
		B-	7
	Very high credit risk	CCC+	6
		CCC	5
		CCC-	4
		CC	3
	Near default with possibility of recovery	SD	2
	Default	D	1

Table 3: The distribution of credit rating events

This table presents the distribution of credit rating events distinguishing between rating upgrades (*U*) and downgrades (*D*) per country and per year, from April 22, 2004 to January 27, 2014 for six Latin American emerging markets: Argentina, Brazil, Chile, Colombia, Mexico and Peru. Rating downgrades are displayed in bold, whereas revisions of ratings (outlooks) are shown in italics.

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	*Total U / D*	*Total*
2004		17-Sep				4-Jun	2 / 0	2
2005	1-Jun	*8-Nov*			11-Jan	*11-Jul* *1-Nov* *3-Nov*	6 / 0	6
2006	23-Mar 2-Oct **3-Nov**	28-Feb *22-Nov*	*14-Dec*	*22-Feb*		20-Nov	7 / 1	8
2007		16-May	18-Dec	5-Mar	*2-Jul* 8-Oct	*23-Jul*	6 / 0	6
2008	25-Apr **11-Aug** **31-Oct**	30-Apr				14-Jul	3 / 2	5
2009					***11-May*** **14-Dec**		0 / 2	2
2010	13-Sep		*16-Dec*	*7-Jul*		*23-Aug*	4 / 0	4
2011		*23-May* *25-Aug* 17-Nov		16-Mar		30-Aug	5 / 0	5
2012	***23-Apr*** **5-Nov**		26-Dec	*15-Aug*		*29-Aug*	3 / 2	5
2013	**10-Sep**	***6-Jun***		24-Apr	*12-Mar* 19-Dec	19-Aug	4 / 2	6
Total U / D	5 / 6	9 / 1	4 / 0	6 / 0	5 / 2	11 / 0	40 / 9	49
Total	11	10	4	6	7	11	49	49

Table 4: The credit rating events' prior and post effect across all countries

This table presents the credit rating events' prior and post effect on average across all the countries and all the events, distinguishing between rating upgrades (*U*) and downgrades (*D*). For any rating event in a given country occurring at time *t*, we test if prior and post effects are significantly different from zero on average for the windows [*t*–*s*,*t*] and [*t*,*t*+*s*] respectively, where *s* denotes the number of days in the window before and after the event. In particular, since the general conclusions hold, the table shows the results obtained for some selected values of *s*. *Significance at the 10% level; **Significance at the 5% level; ***Significance at the 1% level. The sample period ranges from April 22, 2004 to January 27, 2014.

All countries	*Prior-effect*		*Post-effect*	
	U	*D*	*U*	*D*
s = 1	-0.03*	-0.20***	0.03	0.02
s = 2	-0.14**	-0.35***	0.13	0.08
s = 3	-0.21***	-0.49***	0.19**	0.18
s = 4	-0.19***	-0.57***	0.15	0.18
s = 5	-0.17***	-0.74***	0.27**	0.24**
s = 8	-0.18***	-0.58***	0.22**	0.28
s = 10	-0.04	-0.59***	0.14*	0.23
s = 15	-0.02	-0.74***	0.26**	0.30
s = 20	-0.06	-0.77***	0.57**	0.30
s = 25	-0.05	-0.66***	0.34**	0.28

Table 5: The credit rating events' prior and post effect for the individual countries

This table presents the credit rating events' prior and post effect on average from each country to the rest of the non-event countries, distinguishing between rating upgrades (*U*) and downgrades (*D*). For any rating event in a given country occurring at time *t*, we test if prior and post effects are significantly different from zero on average for the windows [*t*–*s*,*t*] and [*t*,*t*+*s*] respectively, where *s* denotes the number of days in the window before and after the event. In particular, since the general conclusions hold, the table shows the results obtained for some selected values of *s*. *Significance at the 10% level; **Significance at the 5% level; ***Significance at the 1% level. The lack of statistics for downgrades in the case of Chile, Colombia and Peru is due to the lack of downgrades for these countries. The sample period ranges from April 22, 2004 to January 27, 2014.

	Panel A: Argentina				Panel B: Brazil				Panel C: Chile			
	Prior-effect		*Post-effect*		*Prior-effect*		*Post-effect*		*Prior-effect*		*Post-effect*	
	U	*D*	*U*	*D*	*U*	*D*	*U*	*D*	*U*	*D*	*U*	*D*
s = 1	0.00	-0.18***	-0.01	-0.05	-0.04	-0.43***	-0.02	-0.06	-0.10*	–	0.06	–
s = 2	0.01	-0.26***	0.58*	0.00	-0.04	-0.78**	0.06	0.18	-0.82**	–	0.29**	–
s = 3	-0.01	-0.67***	0.65*	0.00	-0.04	-0.77**	0.17	0.45*	-0.88**	–	0.42***	–
s = 4	-0.01	-0.67***	0.39	0.00	-0.18*	-1.02**	0.19	0.46	-0.81**	–	0.32**	–
s = 5	0.06	-1.32***	0.43	0.08	-0.21**	-0.90**	0.20	0.57*	-0.76**	–	0.95**	–
s = 8	-0.10	-0.76***	0.48	0.02	-0.19*	-0.96**	0.16	0.74*	-0.62*	–	0.23*	–
s = 10	-0.03	-0.81***	0.16	-0.03	-0.08	-0.99**	0.25*	0.63	-0.55*	–	0.15	–
s = 15	0.13	-1.18***	0.54	-0.06	-0.17	-1.19**	0.24*	0.88*	-0.47	–	0.69	–
s = 20	0.05	-0.86***	0.35	-0.04	-0.25	-1.45**	0.08	1.07*	-0.40	–	0.79*	–
s = 25	0.04	-0.69***	0.39	-0.22	-0.22	-1.27***	0.23	1.21*	-0.26	–	0.17	–
	Panel D: Colombia				Panel E: Mexico				Panel F: Peru			
	Prior-effect		*Post-effect*		*Prior-effect*		*Post-effect*		*Prior-effect*		*Post-effect*	
	U	*D*	*U*	*D*	*U*	*D*	*U*	*D*	*U*	*D*	*U*	*D*
s = 1	0.04	–	-0.21	–	0.03	0.02*	0.00	0.04	-0.12	–	0.02	–
s = 2	0.04	–	-0.20	–	0.06	0.01	0.02	0.07*	-0.11	–	0.02	–
s = 3	-0.05	–	-0.27	–	-0.12***	-0.04**	0.08	0.09**	-0.15**	–	0.10	–
s = 4	-0.01	–	-0.28	–	0.01	-0.03	-0.10	0.08*	-0.13	–	0.39	–
s = 5	0.06	–	-0.25	–	-0.01	0.01	-0.06	0.08*	-0.14*	–	0.36	–
s = 8	-0.07	–	0.08	–	0.04	0.00	0.07	0.08	-0.15*	–	0.28	–
s = 10	0.27	–	0.11	–	0.09	0.04	-0.11	0.09	0.07	–	0.26	–
s = 15	0.15	–	0.14	–	0.23	0.14	-0.20	0.09	0.04	–	0.16	–
s = 20	0.20	–	-0.04	–	0.12	-0.01	2.00*	-0.15	-0.10	–	0.22	–
s = 25	0.28	–	0.08	–	0.20	-0.03	0.93	-0.16	-0.31	–	0.24	–

Figure 1: Daily time evolution of CDS spreads

The figures represent the daily time evolution of the six emerging countries' CDS spreads (Panel A), and the daily time evolution of the emerging market average CDS spreads (Panel B), calculated as the average CDS spreads of all the six emerging countries. The sample period ranges from April 22, 2004 to January 27, 2014 and the countries are the following ones: Argentina, Brazil, Chile, Colombia, Mexico and Peru. The scale in Argentina ranges from 0 to 5,000; for all other countries the scale ranges from 0 to 1,000 and the average CDS spread (Panel B) ranges from 0 to 1,200.

Panel A: Emerging countries' sovereign CDS spreads

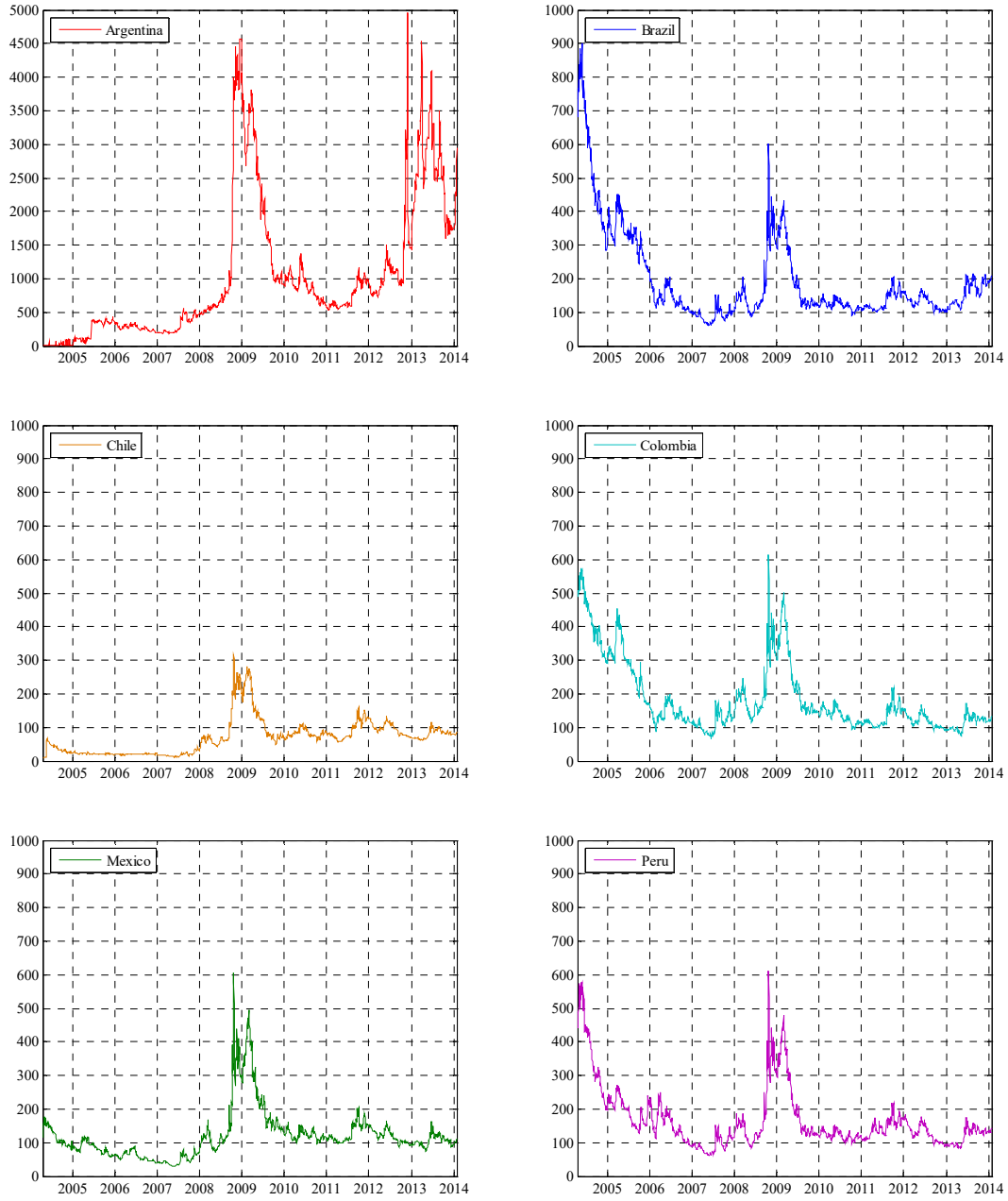


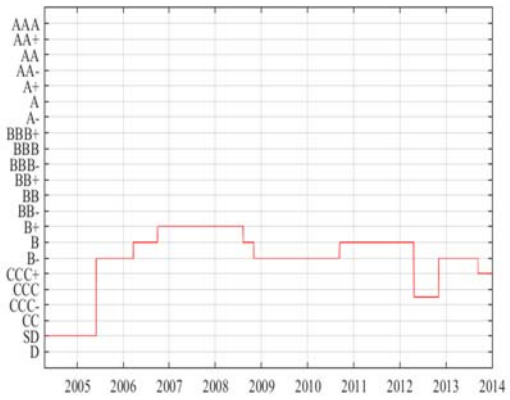
Figure 1: Daily time evolution of CDS spreads *(cont.)*

Panel B: Emerging market average CDS spreads

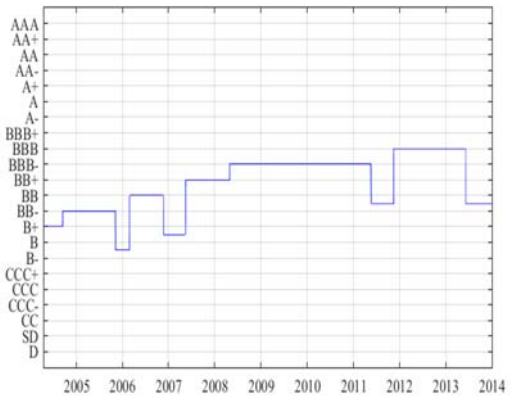
Figure 2: Daily time evolution of S&P's Credit Rating

This figure represents the daily time evolution of S&P's credit rating for the six emerging countries. A rating change (outlook) of category is displayed as an increase (if upgrade) or decrease (if downgrade) of 1 (0.5). The sample period ranges from April 22, 2004 to January 27, 2014.

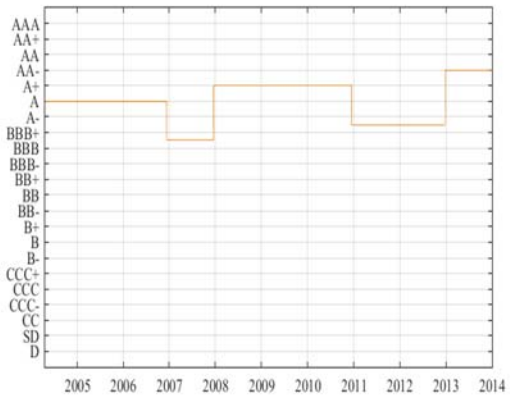
Panel A: Argentina



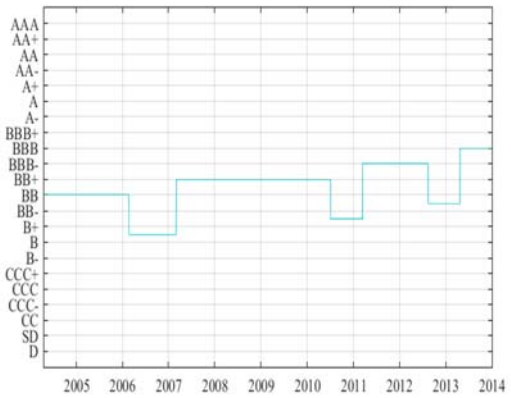
Panel B: Brazil



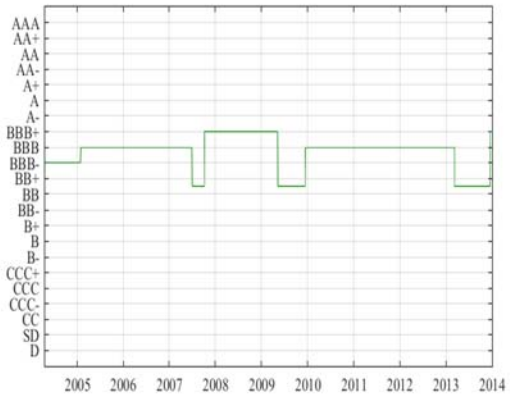
Panel C: Chile



Panel D: Colombia



Panel E: Mexico



Panel F: Peru

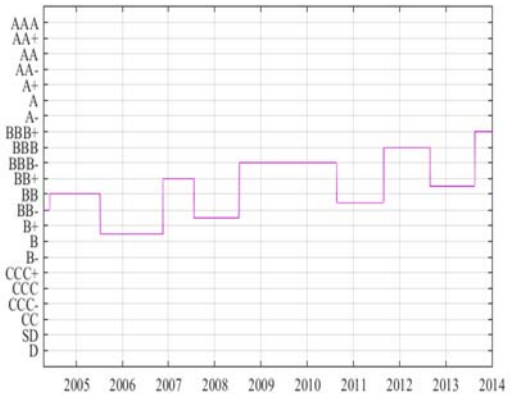
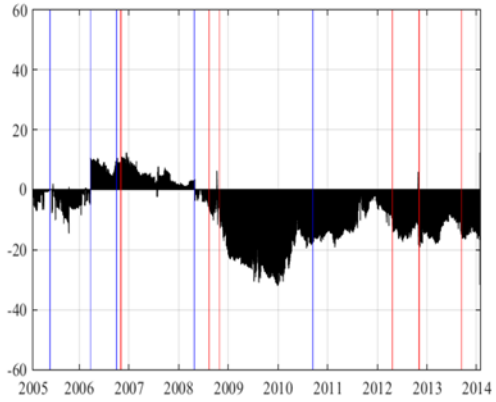


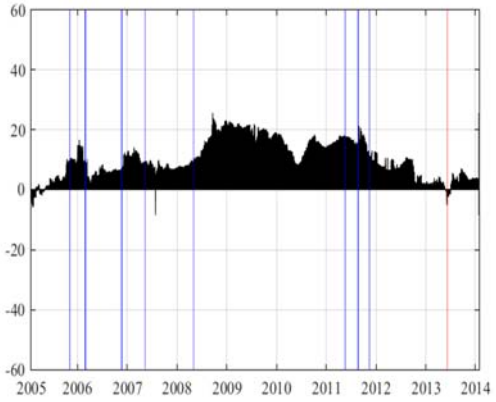
Figure 3: Net-Directional Contagion from a given country to all others

This figure reports the time evolution of the *net directional return spillover* index for contagion (in percentage) transmitted from a given country to all others. Positive (negative) values indicate that the corresponding country is, in net terms, a transmitter (receiver) of contagion to all others. Rating upgrades (downgrades) are displayed in blue (red). The sample period ranges from April 22, 2004 to January 27, 2014, but the index starts on January 27, 2005 since a 200-day rolling window is used to get the evolution over time.

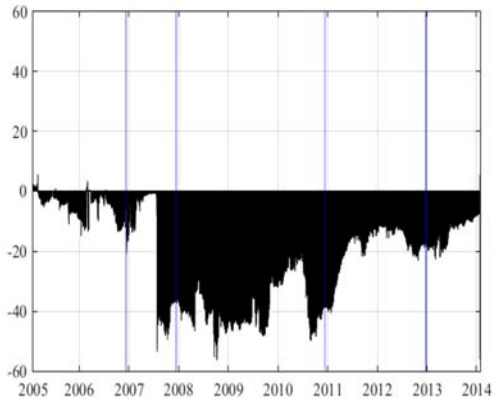
Panel A: Argentina



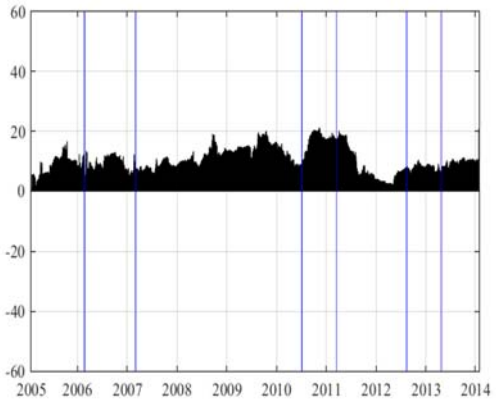
Panel B: Brazil



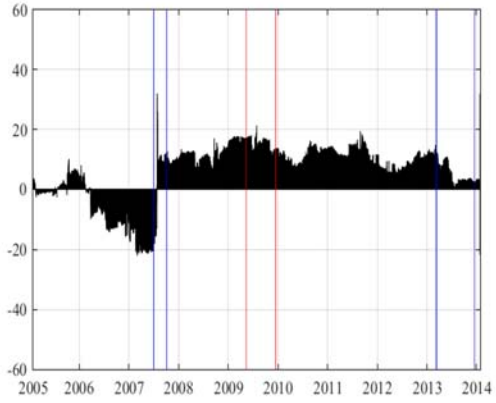
Panel C: Chile



Panel D: Colombia



Panel E: Mexico



Panel F: Peru